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Beam Charge Monitor Integrate-Hold-Reset

User's Manual

Rev. 3.0

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Record of updates

Version	Date	Updates performed
2.1	02/2008	p.6: Oscilloscope plot, trace 3 changed to “Output View”. Oscilloscope plot, trace 1 changed to “Signal View”. p.7: Oscilloscope plot, trace 3 changed to “Output View”.Oscilloscope plot, trace 1 changed to “Signal View”. p.8: Oscilloscope plot, trace 3 changed to “Output View”. Oscilloscope plot, trace 1 changed to “Signal View”. p.15: Trigger delay range specified: 350 ns ... 7.3 us. Ex-factory setting specified as 4 us.
2.2	03/2008	p.3: Refers the user to Annex II for AC Mains Voltage change Instructions Annex II: Delta Elektronika U-Series Mains Voltage change Instructions
2.3	06/2011	p.12: Beam Charge to BCM Input Charge Ratio: 40:1 (instead of 50:1) for ICT with 20:1 turns ratio
3.0	01/2018	Review of the full manual. Obsoletes the previous versions

SUMMARY

INITIAL INSPECTION

It is recommended that the shipment be inspected immediately upon delivery. If it is damaged in any way, contact Bergoz Instrumentation or your local distributor. The content of the shipment should be compared to the items listed on the invoice. Any discrepancy should be notified to Bergoz Instrumentation or its local distributor immediately. Unless promptly notified, Bergoz Instrumentation will not be responsible for such discrepancies.

WARRANTY

Bergoz Instrumentation warrants its beam current monitors to operate within specifications under normal use for a period of 12 months from the date of shipment. Spares, repairs and replacement parts are warranted for 90 days. Products not manufactured by Bergoz Instrumentation are covered solely by the warranty of the original manufacturer. In exercising this warranty, Bergoz Instrumentation will repair, or at its option, replace any product returned to Bergoz Instrumentation or its local distributor within the warranty period, provided that the warrantor's examination discloses that the product is defective due to workmanship or materials and that the defect has not been caused by misuse, neglect, accident or abnormal conditions or operations. Damages caused by ionizing radiations are specifically excluded from the warranty. Bergoz Instrumentation and its local distributors shall not be responsible for any consequential, incidental or special damages.

ASSISTANCE

Assistance in installation, use or calibration of Bergoz Instrumentation beam current monitors is available from Bergoz Instrumentation, 01630 Saint Genis Pouilly, France. It is recommended to send a detailed description of the problem by email to info@bergoz.com.

SERVICE PROCEDURE

Products requiring maintenance should be returned to Bergoz Instrumentation or its local distributor. Bergoz Instrumentation will repair or replace any product under warranty at no charge. The purchaser is only responsible for transportation charges.

For products in need of repair after the warranty period, the customer must provide a purchase order before repairs can be initiated. Bergoz Instrumentation can issue fixed price quotations for most repairs. However, depending on the damage, it may be necessary to return the equipment to Bergoz Instrumentation to assess the cost of repair.

RETURN PROCEDURE

All products returned for repair should include a detailed description of the defect or failure, name and fax number of the user. Contact Bergoz Instrumentation or your local distributor to determine where to return the product. Returns must be notified by fax prior to shipment.

Return should be made prepaid. Bergoz Instrumentation will not accept freight-collect shipment. Shipment should be made via UPS, FedEx or DHL. Within Europe, the transportation service offered by the Post Offices "EMS" (Chronopost, Datapost, etc.) can be used. The delivery charges or customs clearance charges arising from the use of other carriers will be charged to the customer.

SAFETY INSTRUCTIONS

Chassis originally shipped to U.S. or Canada feature AC mains power entry modules where the Phase is fused and the Neutral unfused, as is the rule.

Chassis to other destinations but U.S. and Canada feature AC mains power entry modules where both Phase and Neutral are fused.

When a chassis with unfused Neutral is used outside the U.S. and Canada, both Phase and Neutral should be fused:
The Power entry module must be opened, the Neutral fuse must be removed, the fuse holder must be flipped; its reverse side presents two slots where two new fuses must be inserted, one in each slot.
The fuses rating must be same as the Neutral fuse that was removed.

BCM-IHR SET

BCM current version

BCM-IHR-E Beam Charge Monitor, Integrate-Hold-Reset version is the object of this manual. It consists of at least one BCM-IHR-E electronics module and one BCM-RFC/xx 3U x 19" chassis.

This User's manual does not describe older BCM versions, housed in an ABS plastic enclosure. Those are described in other manuals:

- Beam Charge Monitor, Integrate-Hold-Reset User's Manual, version 1.x.x.
- Beam Charge Monitor, Continuous Averaging User's Manual, version 1.x.x

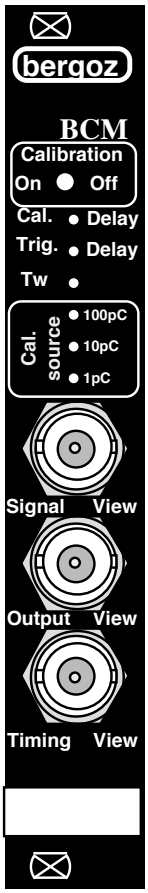
These older versions consist of three modules in an ABS plastic enclosure, marked:

- "C.A.C." for Charge Amplifier and Calibration
- "BSP-CA" or "BSP-IHR" for Bunch Signal Processor
- a Delta Elektronika or Schroff power supply module

These older configurations may include a Wideband Amplifier.

Front panel

Module BCM-IHR-E



Font panel

WARNING: Jumpers configuration & Potentiometers settings

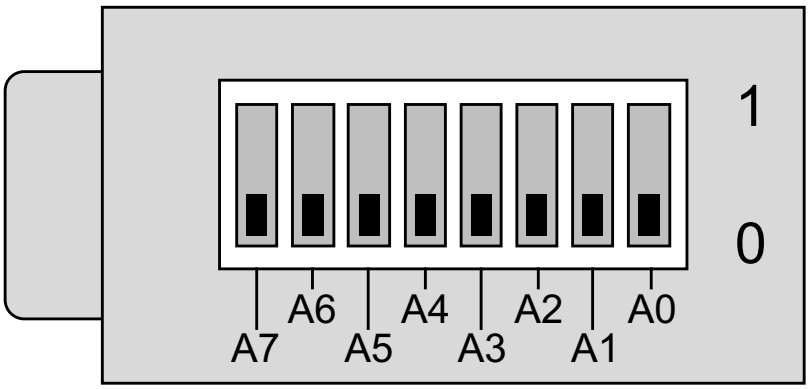
The BCM-IHR-E is in the "Ex-factory" configuration. Jumper and timing adjustments (potentiometers) have been configured according to the order.

Do not change those settings until you are familiar with the Beam Charge Monitor.

DB9 Remote control key

A "DB9 Remote control key" is supplied with the Beam Charge Monitor. Its purpose is to control the BCM-IHR-E ranges when the accelerator control system is not connected. It is a small auxiliary printed board attached to a DB9 connector. An 8-bit switch is mounted on the printed board.

It must be plugged to the DB9 Remote control connector at the rear of the BCM chassis to allow range switching and calibration range switching during tests.



Switches A0...A6 are active. They correspond to Bits 0...6 of the remote control (See "Remote Range and Calibration Switching", this manual).

Position 1 corresponds to bit HIGH. Position 0 corresponds to bit LOW.

Switch A7 is not connected. Bit 7 controls "Calibration Enable". This function can be enabled during tests by the BCM front panel switch.

GENERAL DESCRIPTION

BCM-IHR-E, Beam Charge Monitor Integrate-Hold-Reset version is designed to read the output signal of an ICT Integrating Current Transformer. BCM-IHR-E measures the charge in a pulse or macropulse when it is triggered by an external trigger signal. It supports pulse/macropulse repetition rates from 1 kHz down to single pulses

System components

ICT Integrating Current Transformer is the sensor matching BCM-IHR-E. ICT is available in two styles:

- In-flange ICT to be bolted in the beam line
- In-air ICT to be installed over the vacuum chamber

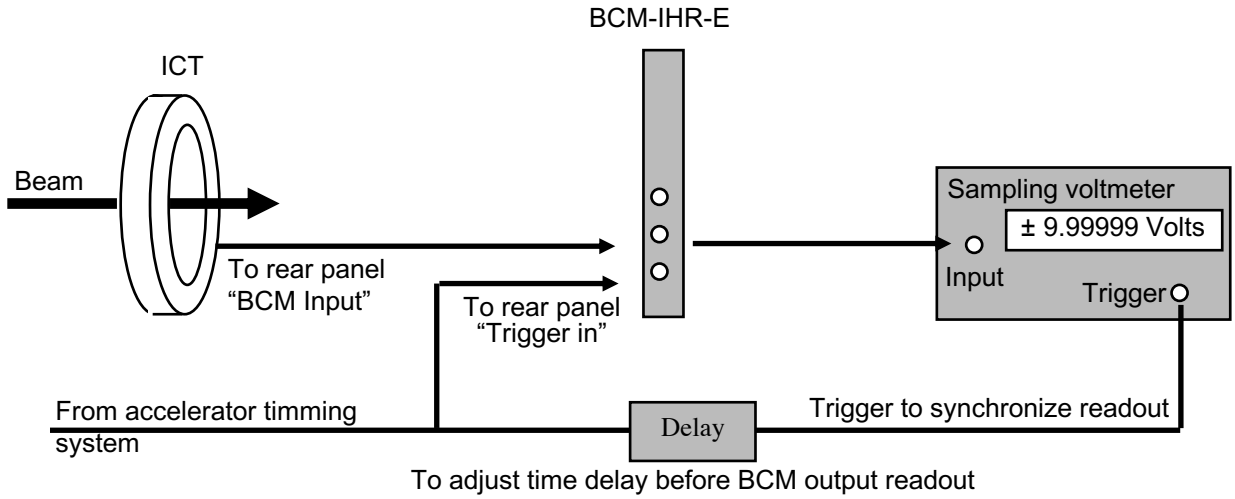
Both styles of ICT and their respective installations are described in "ICT Integrating Current Transformer User's Manual".

BCM-IHR-E processes the beam signal from ICT.

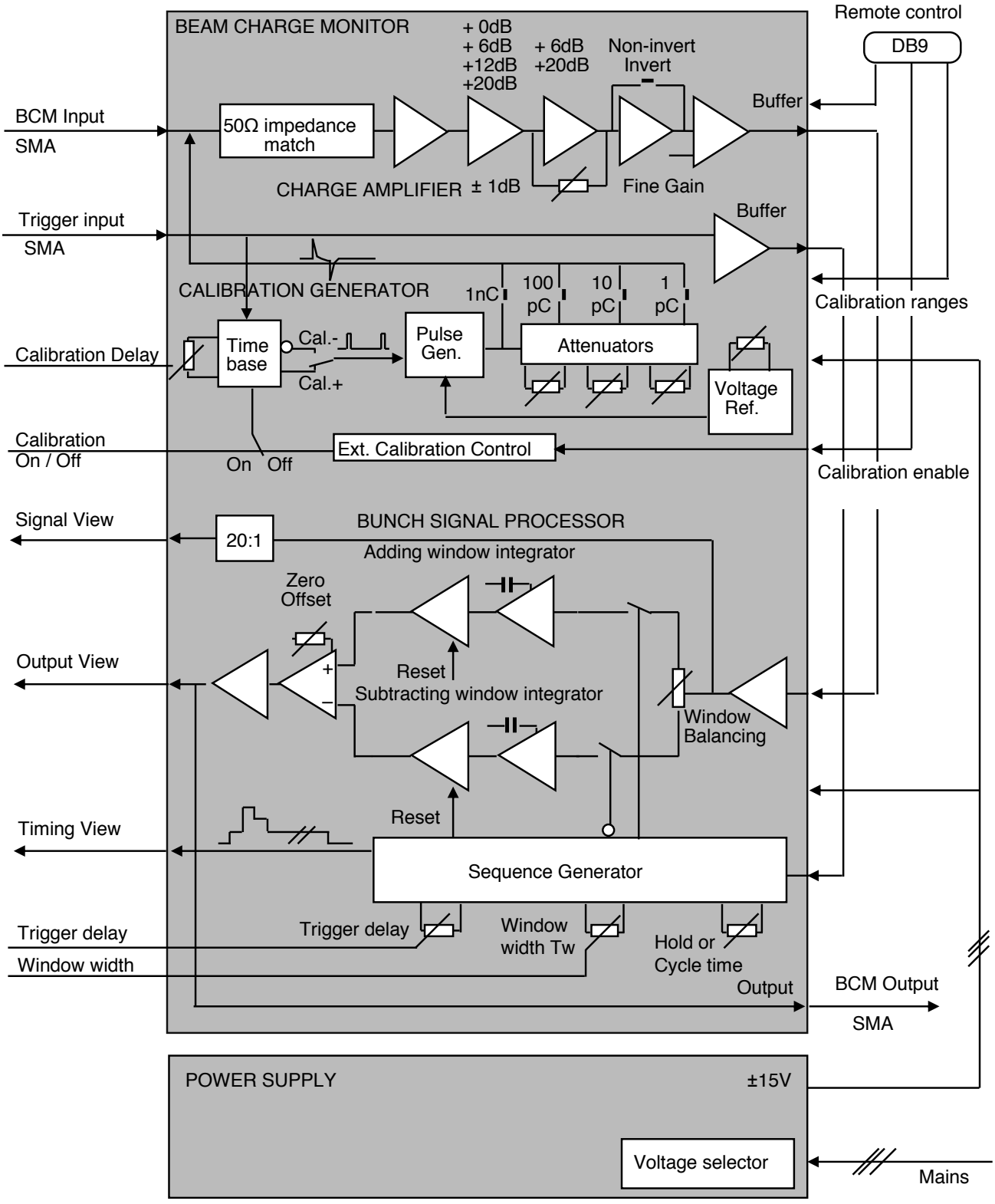
Electronics are housed in a 3U-high, 19"-wide RF-shielded chassis, which can hold:

- BCM-IHR-E, BCM-RF-E or BCM-CW-E modules, in any mix.
- Power Supply.

BCM-IHR-E output is a voltage up to +-7V, proportional to the beam charge.
The voltage level is held up to 400µs, then resets.



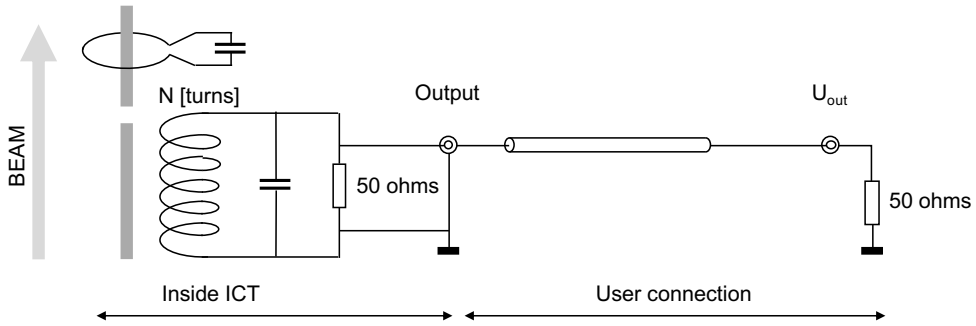
ARCHITECTURE



OPERATING PRINCIPLE

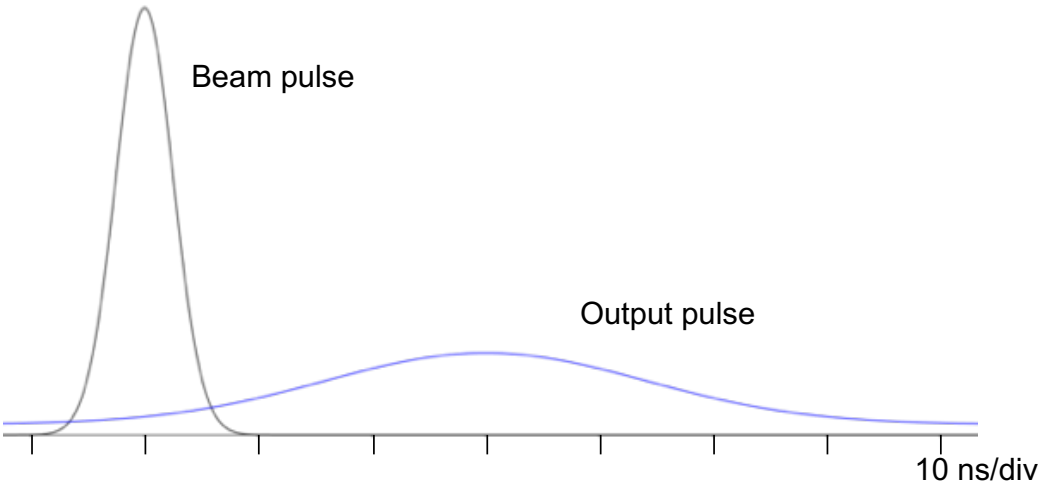
Integrating Current Transformer

ICT Integrating Current Transformer is a passive transformer designed to measure the charge in a very fast pulse with high accuracy. It is capable of integrating a pulse with rise time down to femtoseconds with no significant loss.



The ICT is a capacitively shorted transformer coupled to a fast readout transformer in a common magnetic circuit[1].

It delivers a pulse with ca. 20 ns rise time irrespective of the beam pulse rise time. The ICT output pulse charge is in exact proportion to the beam pulse charge.



The sensitivity of the Integrating Current Transformer is also called the transfer impedance. It depends on the ICT model. It is expressed in terms of the integral of the output pulse voltage as a function of the input pulse charge, therefore in V.s/C, or Ω.

[1] Measuring Bunch Intensity, Beam Loss and Bunch Lifetime in LEP, K.B.Unser, Proceedings of the 2nd European Particle Accelerator Conference, 1990, Vol.1, p.786

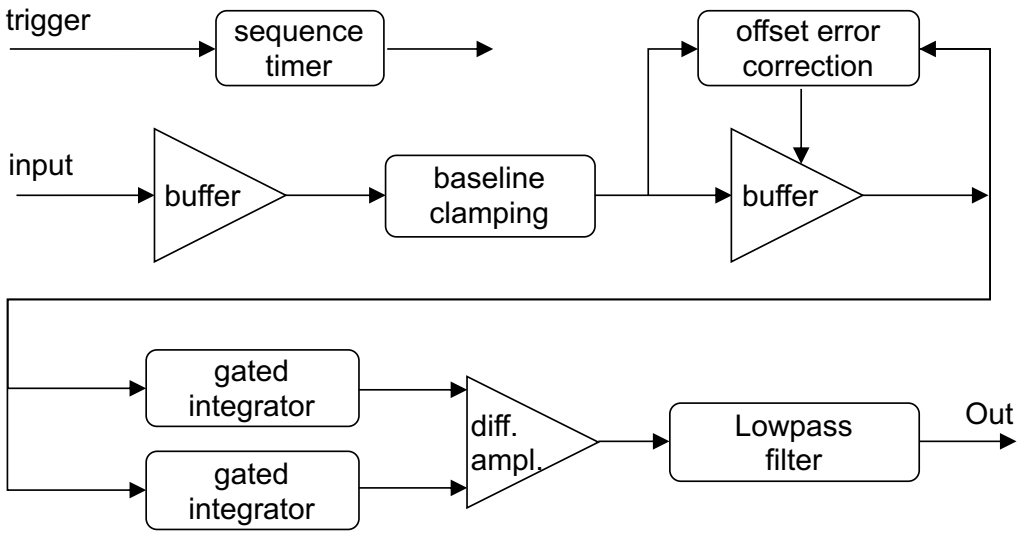
Cable connection

Most 50Ω coaxial cable types are appropriate to connect the ICT to its measuring instrument. To measure charge below 500 pC, depending on the RFI background noise, consider using a double-shielded cable.
When the ICT signal is integrated, its integration is not affected by the cable attenuation. It is only affected by the ohmic resistance of the cable's center conductor.

Signal processing

The signal is amplified by the Charge Amplifier. The amplified signal is entered in the Bunch Signal Processor, which integrates this signal every time the BCM-IHR-E is triggered by an external trigger. This gives the possibility to measure selected pulses only, not necessarily at a fixed repetition rate.

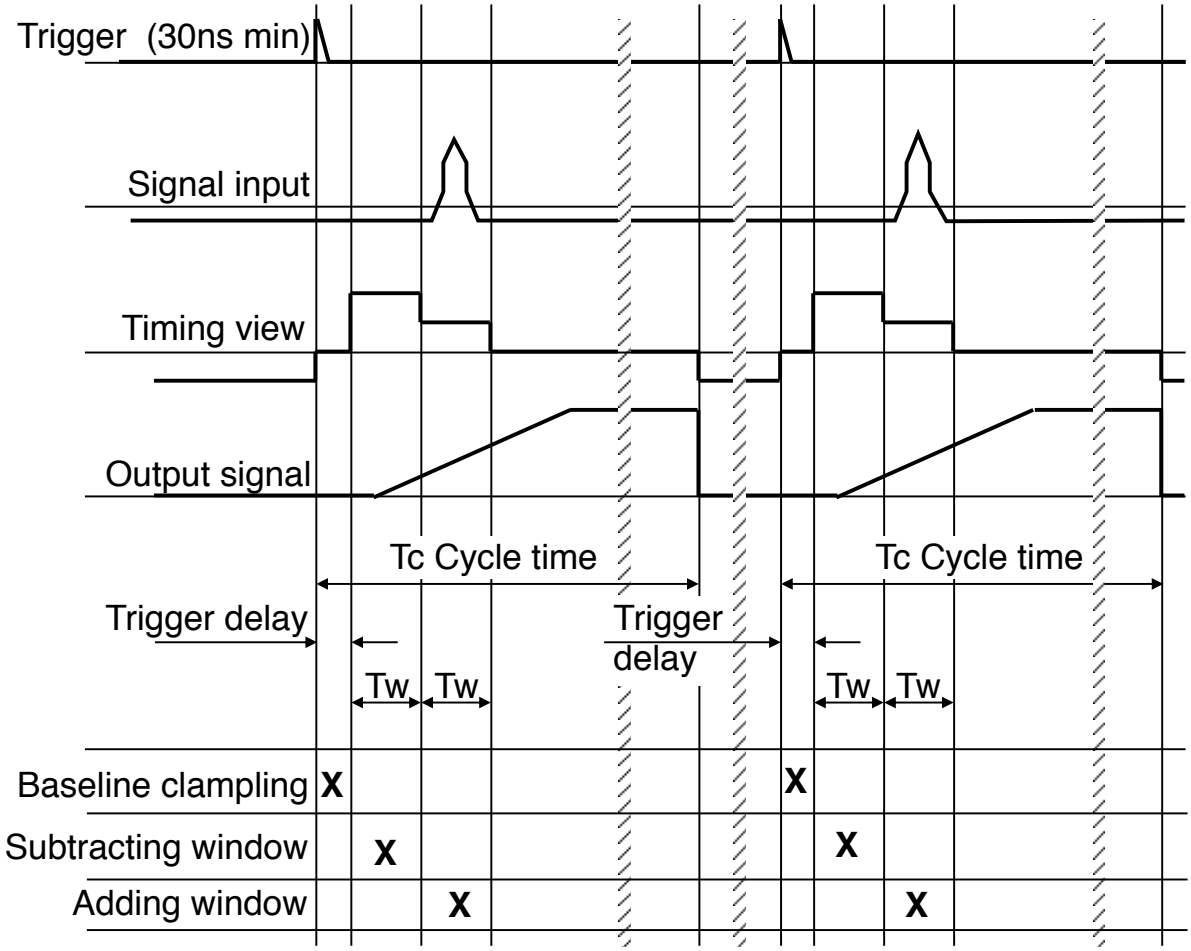
The signal processing is initiated by the external positive-going trigger pulse. A sequence timer creates three successive time windows: a trigger delay, a subtracting window and an adding window. The pulse to be integrated must fall either in the adding window, or the subtracting window. Pulses falling in the first window or trigger delay are not integrated.
At the start of the first integration window, the baseline is clamped to set the zero reference. The two integration windows are used to integrate the input signal in two independent integrators.



One integrator integrates the pulse signal. The other integrates the input noise and baseline offset. The pulse charge is obtained by summing the two integrators: the first with negative sign, the second with positive sign.

This particular combination of sampling window integrators gives a high degree of noise suppression. All signals which do not correlate in frequency and in time with the window timing are rejected. This is true for the amplifier noise and also for the general background. The balance of integrators gains is user-adjustable with the Window Balancing potentiometer.

Timing of the BCM-IHR



Trigger delay is adjustable from 350 ns minimum to 7.3 us maximum with front-panel potentiometer "Trig. Delay". In ex-factory conditions, it is set to 4 us.

The two integration windows are of equal width "T_w". T_w is adjustable with front-panel potentiometer "T_w".

The Hold time or Cycle duration T_c can be adjusted by potentiometer "Cycle (Hold) Time". It is located on the BCM-IHR-E board. The cycle duration T_c must not be made shorter than the sum of the trigger delay and the two integration windows. For Cycle (Hold) time longer than can be adjusted with the potentiometer, please contact factory at info@bergoz.com.

To locate on-board potentiometers, pls. refer to chapter "Settings", in this manual.

Beam Charge Monitor Output

The output is a DC level up to +-7V, proportional to the pulse charge. The output voltage is the difference between the value of the Subtracting Integrator and the Adding Integrator. The output may have an offset. This output zero offset is user adjustable with on-board "Output Zero Offset" potentiometer. To eliminate this offset and make precision measurement, see chapter "Making precise measurements with the BCM-IHR-E", in this manual.

The output is available on the SMA connector on the chassis rear panel. A front-panel BNC is available for oscilloscope viewing: "Output View".

Warning: Loading the front-panel "Output View" may change the rear panel "BCM Output".

The output is the value of the last selected pulse only. The signal settles in < 20 μs after the end of the second window; it is held at that level until the end of the cycle, then it resets to zero. The Cycle time Tc or "Hold time" can be adjusted with on-board potentiometer "Cycle (Hold) Time".
To locate on-board potentiometers, pls. refer to chapter "Settings", in this manual.

On-line calibration

On-line calibration is possible at any time when there is no beam. Even when the no-beam time is short, on-line calibration may still be possible. BCM-IHR-E is equipped with a precise Calibration Generator.

The Calibration generator is enabled when the front-panel switch "Calibration" is turned ON. The Calibration Generator can also be enabled by applying a high level to the "Calibration" pin on the BD9 connector. When the Calibration Generator is enabled, it sends two calibrated pulses, one positive, the other negative, a short time after it receives a trigger. The delay between the trigger and the first calibration pulse can be adjusted with the front-panel potentiometer "Cal. Delay". The calibrated pulse is applied to the BCM-IHR-E input charge amplifier. For correct calibration, the beam current transformer and its cable must be connected to BCM input located on the BCM chassis rear panel.

The pulse charge splits in two parts: one part is lost in the cable and the current transformer. The remaining charge is amplified by the Charge Amplifier. "Cal. Delay" must be adjusted to make the calibrated pulse fall within either of the BCM-IHR-E integration windows.

The purpose of the pulse charge generator is not to provide accurate calibration. The calibration pulse generator provides pulses calibrated to ca. ±2%.

"Calibration Enable" controls the calibration charge value, from 1 pC, 10 pC, 100 pC up to 1 nC and the calibration pulse polarity. Controls are selected by TTL external levels applied to the DB9 connector at the rear of the BCM chassis.

Beware, this is charge as applied to the input of the Charge Amplifier. It is not beam pulse charge equivalent!

To obtain beam charge equivalents, use the table hereafter:

Calibration pulse in pC		1	10	100	1'000
Equivalent beam pulse, in pC					
With sensor:					
ICT-XXX-XXX-0.50	Exactly	100	1'000	10'000	100'000
ICT-XXX-XXX-1.25	Exactly	40	400	4'000	40'000
ICT-XXX-XXX-2.50	Exactly	20	200	2'000	20'000
ICT-XXX-XXX-5.00	Exactly	10	100	1'000	10'000
ICT-XXX-XXX-10.0	Exactly	5	50	500	5'000

BCM-IHR SYSTEM CHECK

Voltage Check

BCM chassis may be equipped with either:

- Delta Elektronika power supply units[2]. These units will soon be discontinued.
- Modules integrating Minmax AKF-15D15 power supply blocks[3]. They replace the Delta Elektronika power supply units.

If the BCM chassis is equipped with Delta Elektronika power supplies, check that the voltage corresponds to your mains voltage. The power supply voltage is indicated on a plastic label located on the power supply module front panel.
If it does not correspond, go to Annex I: *Delta Elektronika U-Series linear power supply AC Mains Voltage change Instructions* to adjust the power supply to your mains. Then change the fuse and front-panel and rear panel plastic labels accordingly.

If the BCM chassis is equipped with Minmax AKF-A5D15 power blocks, their AC main input range is 85Vac to 263 Vac, 50/60Hz.
If the mains voltage does not fall within those limits, contact factory at info@bergoz.com.

Package check

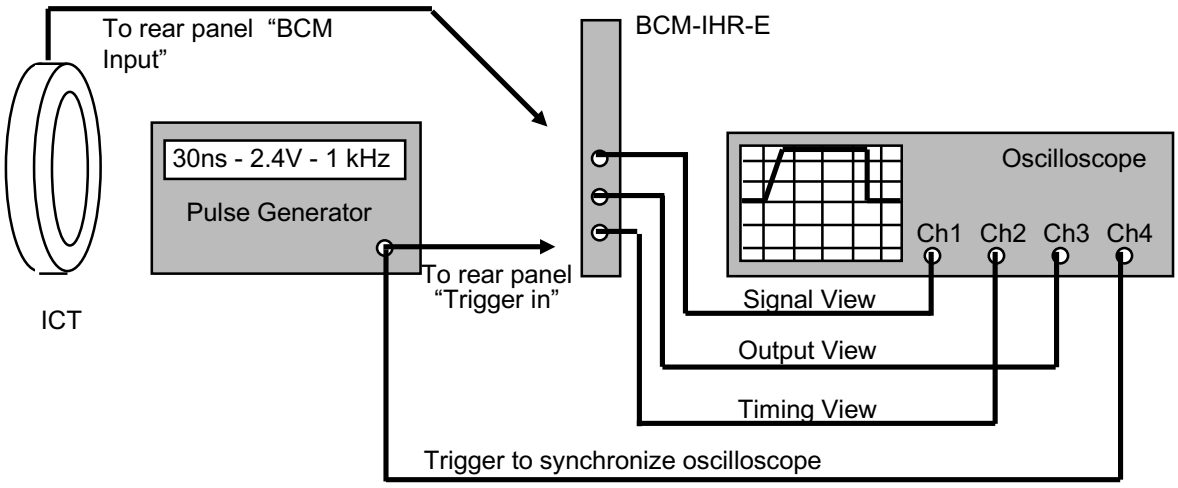
You can check immediately that your BCM system is working. This is what you need:

- Beam Charge Monitor Integrate-Hold-Reset: At least one BCM-IHR-E electronics module and one BCM-RFC/xx chassis
- DB9 Remote control key
- ICT Integrating Current Transformer
- 4-channel oscilloscope with 100 MHz bandwidth
- Pulse generator capable of making the trigger pulse (≥30 ns, ≥2.4V, 1 kHz)

You will also need short (4-8 ns) BNC cables and SMA-BNC adapters.

[2] http://www.delta-elektronika.nl/upload/MAN_5U15-15.pdf
[3] https://www.minmax.com.tw/en/download/files/1351/AKF-15_Datasheet.pdf

Setup



Connect as shown on picture:

ICT to "BCM Input" on BCM chassis rear panel.
Insert DB9 "Remote Control" key in chassis rear panel DB9 connector.

Note: All Remote Control switches should be OFF,i.e., on "0" (zero).

Reminder: Make sure the AC mains voltage corresponds to BCM mains voltage.
Connect BCM chassis AC input to the mains.

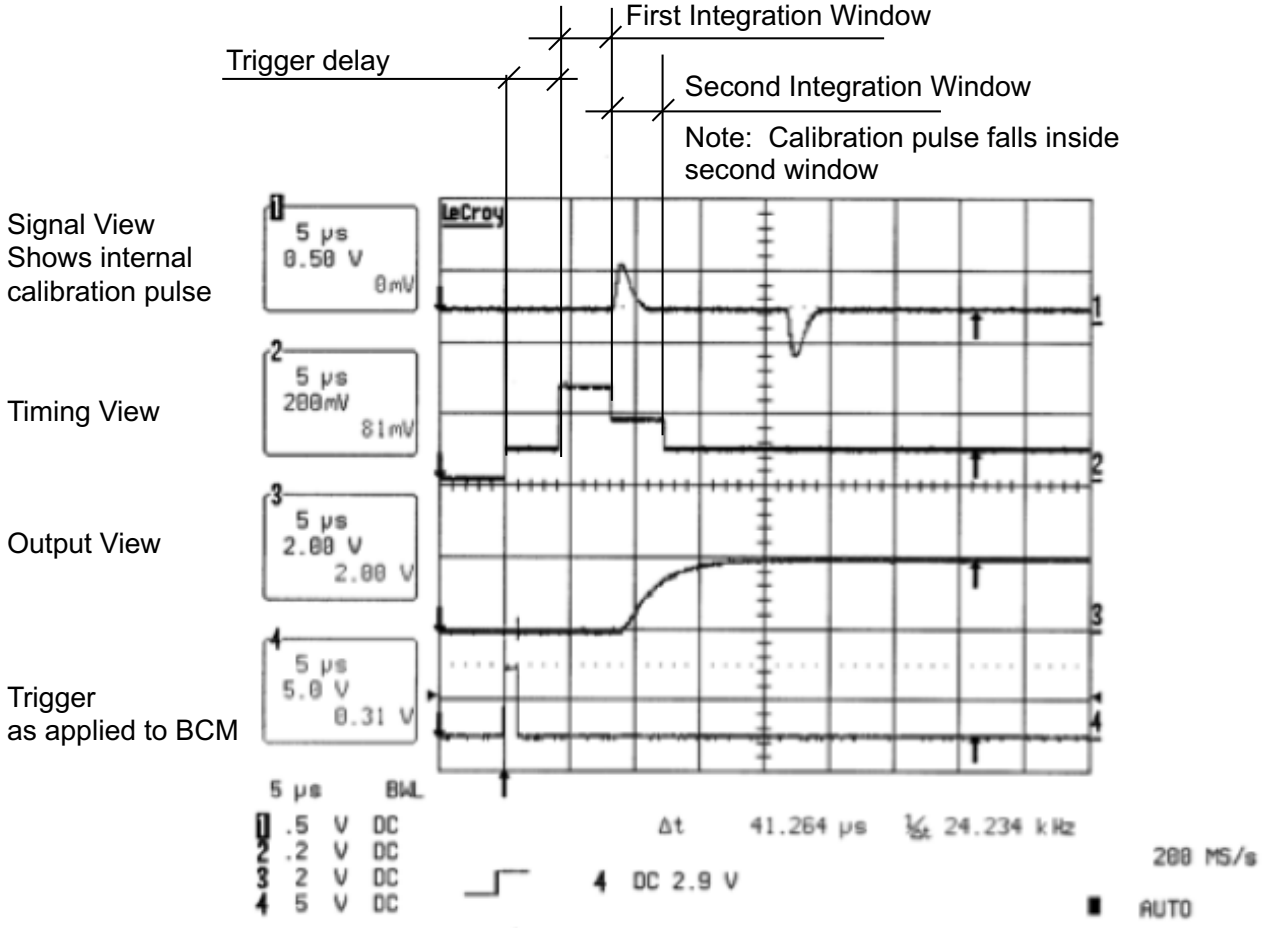
Apply a 50-ohm pulse (>30ns, >2.4V, 1 kHz) to "Trigger in" on rear panel.
Apply same pulse to oscilloscope input channel, to trigger oscilloscope.
Set this oscilloscope input channel to high-impedance.

Turn front-panel "Calibration" toggle switch ON.
Look at the signals with the oscilloscope, all channel inputs must be high-impedance.
All View points are on the front panel BNCs.

Waveforms

Reminder: The front panel "Calibration" toggle switch should be ON.

The signals should look like this:



Exercising the module:

Turn the BCM-IHR-E "Cal. Delay" 20-turn front panel potentiometer: It changes the delay between the trigger and the calibrated pulse. The calibrated pulse can be moved from the second window (the "adding" window) into the first window (the "subtracting" window).

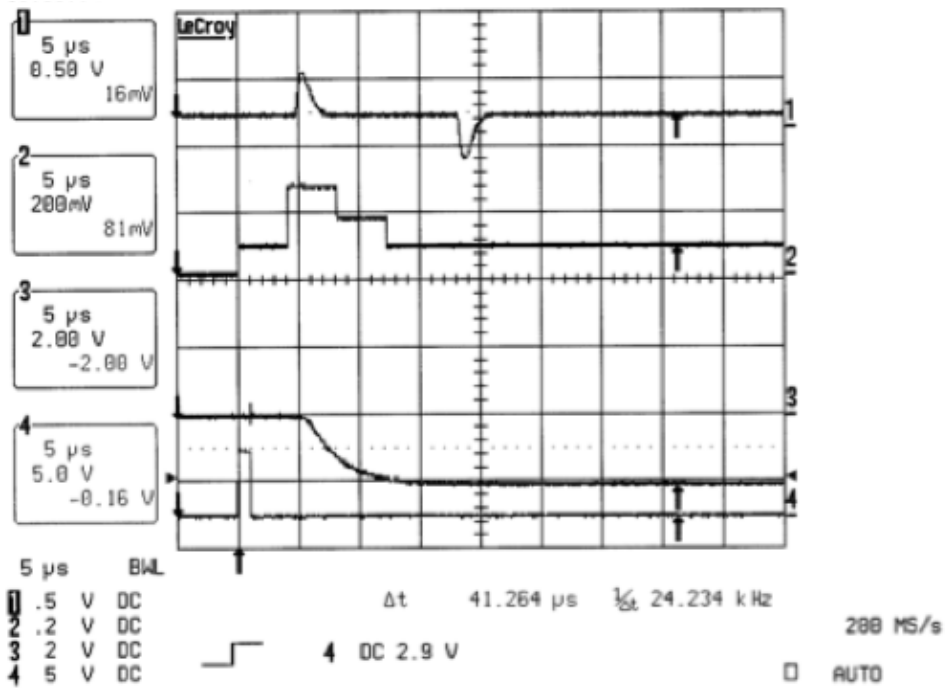
When the calibrated pulse fits entirely into the first (subtracting) window, it should look like this:

Signal View
Shows internal
calibration pulse

Timing View

Output View

Trigger
as applied to BCM



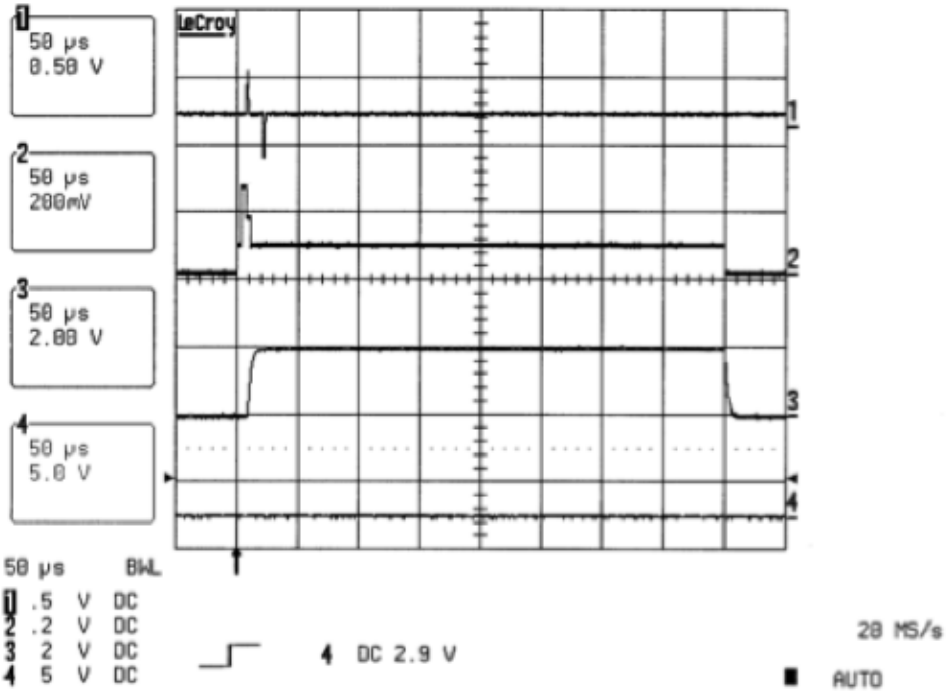
Adjust the oscilloscope time base to a slower sweep: 50 µs / div. It should look like this:

Signal View
Shows internal
calibration pulse

Timing View

Output View

Trigger
as applied to BCM



The complete BCM-IHR-E cycle is visible on the oscilloscope including the BCM output reset to zero.

Explanation of the Timing View:

The Timing View is a signal to help the user:
a) adjust the beam pulse inside the integration window
b) adjust the timing of his readout ADC or sampling voltmeter with the BCM output signal.
The Timing View voltage levels are arbitrary.

- Signal lowest level, at the beginning of the trace: Beam Charge Monitor is ready to receive a Trigger.

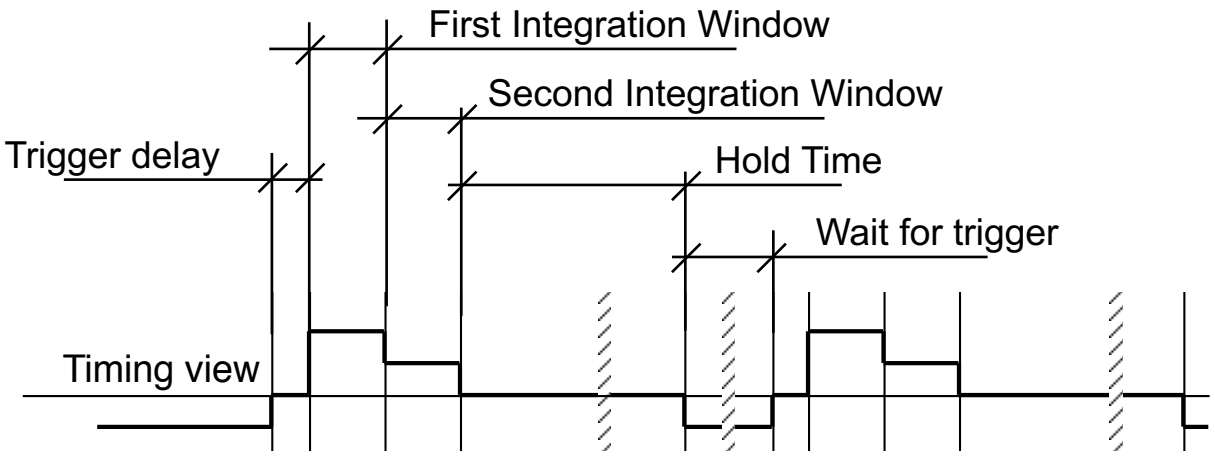
- First step is up: BCM-IHR-E has received Trigger. The Trigger delay is elapsing (4μs in ex-factory conditions)

- Second step is up: The trigger delay has elapsed. The first integration window starts. In ex-factory conditions it lasts 4 μs. During this window, the signal is summed in the output with a negative sign. It is the "Subtracting" window.

- Third step is down: The first or "Subtracting" window has closed. The second window starts. In ex-factory conditions, this window has equal duration to the first window duration. During this window, the input signal is summed with a positive sign. It is the "Adding" window.

- Fourth step is down: The second window has closed. The Hold time starts. During the hold time, the BCM-IHR-E output value is held. In ex-factory conditions the Hold time terminates 400 μs after the trigger.

- Final step is down: The Hold time is finished. The BCM-IHR-E output is reset to zero. The Beam Charge Monitor is ready to receive another Trigger.



The BCM-IHR system does not behave as described

If your BCM-IHR-E is in ex-factory conditions, it should behave as described. If it does not, check the switch settings on the "Remote Control" key: All switches should be in the OFF, i.e., "0" (zero) position.

If your BCM-IHR-E is not anymore in ex-factory conditions, the front panel potentiometers settings may have been changed.

To re-establish the ex-factory settings:

- Turn potentiometer "Trig. Delay" located on BCM-IHR-E front-panel until the Trigger delay equals 4 μs.
- Turn potentiometer "Tw" located on BCM-IHR-E front-panel until the integration window width equals 4 μs.
- Turn potentiometer "Cal. Delay" on BCM-IHR-E front panel until the calibrated pulse fits into an integrating window.

If those adjustments cannot be carried out, the instrument's time constants have probably been changed after delivery of the instrument. Either restore original values according to the schematics or contact manufacturer for recalibration at info@bergoz.com.

Testing all other BCM-IHR-E functions

You can test all gain ranges, inverse the signal polarity, change the value of the calibration pulse and its polarity:

Toggle the switches of the DB9 Remote control key. Place the switches A0 to A6 according to "Remote Range and Calibration Switching". Switch position 1 corresponds to bit HIGH. Position 0 to bit LOW.

Note that Switch A7 is not connected. The "Calibration Enable" control can be activated with the BCM-IHR-E front panel toggle switch.

SENSITIVITY OF THE BCM-IHR-E

Full scales

Gain	Bits (Gain setting) 2-1-0	Full scale with ICT-…-0.50	Full scale with ICT-…-1.25	Full scale with ICT-…-2.50	Full scale with ICT-…-5.00	Full scale with ICT-…-10.0
6 dB	H-H-H	400 nC	160 nC	80 nC	40 nC	20 nC
12 dB	H-H-L	200 nC	80 nC	40 nC	20 nC	10 nC
18 dB	H-L-H	100 nC	40 nC	20 nC	10 nC	5 NC
20 dB	L-H-H	80 nC	32 nC	16 nC	8 nC	4 nC
26 dB	L-H-L or H-L-L	40 nC	16 nC	8 nC	4 nC	2 nC
32 dB	L-L-H	20 nC	8 nC	4 nC	2 nC	1 nC
40 dB	L-L-L	8 nC	3.2 nC	1.6 nC	0.8 nC	0.4 nC
Bits: L = low, H= high						

Most sensitive configuration

The most sensitive configuration is obtained when using the most sensitive beam current transformer.
With two cores in parallel with 5:1 turns ratio ICT, and BCM set to maximum gain (+20 dB on first stage and +20 dB on second stage), then:

- Full scale is ±400 pC for ±8V output
- Sensitivity is ca. 10 mV per pC of beam charge
- Noise is < 1 mVrms, i.e < 1 pC beam charge
- Dynamic range is > 800.

Least sensitive configuration

The least sensitive configuration (without external signal attenuators) is limited by the saturation of the circuits.
With a 50:1 turns ratio ICT, and the BCM-IHR-E set to minimum gain (+0 dB on first stage and +6 dB on second stage), then:

- Full scale is ±400 nC for ± 8 Volts output
- Sensitivity is ca. 20 mV per nC of beam charge
- Noise is < 0.2 mV rms, i.e. 10 pC beam charge
- Dynamic range is ≈ 40000.

REMOTE RANGE and CALIBRATION SWITCHING

All BCM-IHR-E functions can be controlled by 8 bits. Apply TTL levels to these 8 bits via the rear-panel DB9 connector. An 8-bit DIP switch, attached to a DB9 male connector, is provided for user convenience, to simulate the presence of the control system. The BCM-IHR-E gain level, signal polarity, Calibration pulse charge and Calibration pulse polarity can be controlled.

Function				Bit#7	Bit#6	Bit#5	Bit#4	Bit#3	Bit#2	Bit#1	Bit#0
DB9 connector pin# (ground on pin#9)				5	1	6	2	7	3	8	4
Gain	Total	2nd stage	1st stage								
	+6 dB	**+6 dB**	**+0 dB**						**H**	**H**	**H**
	+12 dB	+6 dB	+6 dB						H	H	L
	+18 dB	+6 dB	+12 dB						H	L	H
	+20 dB	+20 dB	+0 dB						L	H	H
	+26 dB	+20 dB	+6 dB						L	H	L
	+26 dB	+6 dB	+20 dB						H	L	L
	+32 dB	+20 dB	+12 dB						L	L	H
	+40 dB	+20 dB	+20 dB						L	L	L
Output Signal	Polarity		**Non invert**					**H**			
			Invert					L			
Calibration	Polarity		**Positive**				**H**				
			Negative				L				
	Charge selection		**1 nC**		**H**	**H**					
			100 pC		H	L					
			10 pV		L	H					
			1 pC		L	L					
	Enable/Disable		**Enable***	**H**							
			Disable	L							
*Calibration Enable and "Calibration" front-panel switch ON are OR'ed. Therefore, BCM will be in calibration mode whenever either Calibration Enable of "Calibration" switch is ON.											
Bits: L = low, H= high											

Notes: The default state, i.e. the state when no external control signal is applied, is printed in **BOLD**.

SPECIFICATIONS

Beam Charge Monitor

Input charge	4 nC max
Input rise time	< 1ns in 50Ω termination
Gain steps	7 steps from 37 dB to 71 dB
Gain, fine adjustment	± 1 dB
Output	bipolar, up to ± 10 V, for high-impedance readout Output load 10 mA max. Best linearity up to ±7V
Output settling time	< 30 μs after the trigger
Output signal hold time	up to 600 μs after the trigger (pot. adjustable)
Front-panel connectors (BNC)	Signal View, for oscilloscope viewing Output View (for oscilloscope) Timing View (for oscilloscope)
Rear module connector	DIN 41612-M / 24+8 male, with 1.0/2.4 coaxial inserts
Back-panel connectors (SMA)	BCM Input, 50-ohm coaxial cable from ICT BCM Output, for high-impedance readout Trigger Input, 50-ohm
Back-panel DB9 female:	8 TTL controls for Range control, Calibration Control and Calibration Enable
Front-panel switch	Calibration on/off
Front-panel potentiometers	Calibration delay (to fit the calibration pulse in the integrating window) Trigger delay (To adjust time from trigger to beam pulse) Window width "T_w" (To adjust integration window time)
Recessed front-panel potentiometers	Calibration Source (To fine-trim the calibration generator)
On-board potentiometers	Fine Level: gain adjust ±1dB Window Balancing Cycle (Hold) time Output Zero Offset
Calibration pulse absolute accuracy	±2%
Power consumption (module)	+15V, 110mA -15V, 85mA
Card size	3U x 4F, i.e. Eurosize 100 x 160 mm, 20mm wide
Chassis size	3U x 19"

Power supply and fuses

The mains voltage is factory set according to the label stuck on the front panel.
Please remove this label when you change the mains voltage selection.

Type	5U 15-15 modular plug-in ±15V linear power supply[4]
Manufacturer	Delta Elektronika, 4300A Zierikzee, The Netherlands
Output voltage	±15V, 200 mA
Mains voltage	jumper selected: 110, 220 Vac, 50-60 Hz tested at 90 Vac/50 Hz for 100 Vac Japanese mains voltage
Mains voltage selector	located under the power supply block
Card size	3U x 10F, i.e. Eurosize 100 x 160 mm, 50mm wide
Back-panel connector	The Power supply mains are wired to a IEC connector via an EMI/RFI filter and fuse.

[4] http://www.delta-elektronika.nl/upload/MAN_5U15-15.pdf

MAKING PRECISE MEASUREMENTS WITH THE BCM-IHR-E

It is recommended to use a sampling voltmeter with programmable statistics capabilities to read the BCM-IHR-E output signal. A sampling voltmeter is suitable for this application, most sampling voltmeter average the voltage between time limits and hold the resulting value.
The voltmeter reading must be started (triggered) when the BCM-IHR-E output pulse is stable, i.e. ≥20µs after the BCM-IHR-E trigger pulse.
For precise measurement, the voltmeter should sample the BCM-IHR-E output over 2-300µs and calculate the average.

For ultimate precision, the BCM-IHR system readout should execute two measurement cycles:
- First measurement is with beam pulse.
- Second measurement is without beam pulse, to measure the zero offset.

The offset is deducted from the first measurement to obtain a precise value.

This technique has two advantages:
a) The value of the zero, which depends on the balancing between the Adding and the Subtracting integrators, is compensated. Any drift of the zero (due to temperature or ageing) is eliminated.
b) The mains frequency noise can be eliminated.
   For 60 Hz mains, the noise can be rejected very effectively by making the two measurements at a time interval equal to N x 16.66ms, where N is an integer 1, 2, 3....
   For 50 Hz mains, the time interval must be equal to N x 20 ms.

ADS cards too, with appropriate software, can be used: a minimum of 16 bits resolution is recommended, averaging many value during BCM-IHR-E hold time minimize the noise collected by the cable from BCM chassis to the ADC. Measuring and deducting the zero offset -as described above- can be used for higher precision.

SETTINGS

Front-panel potentiometers

Window width "T_w"
Determines the width "T_w" of the integration windows.
Allows an adjustment from <0.1 µs up to >7 µs.
Factory set as shown on the "Factory Settings" label affixed to the BCM module.

Trig. delay
Adjusts the delay from the trigger until the beginning of the first integration window.
Factory set as shown on the "Factory Settings" label affixed to the BCM module.

Cal. Source
Allows fine trimming of the calibration generator. Please note: Ex-factory calibration will be lost when Cal. Source potentiometer settings are modified.

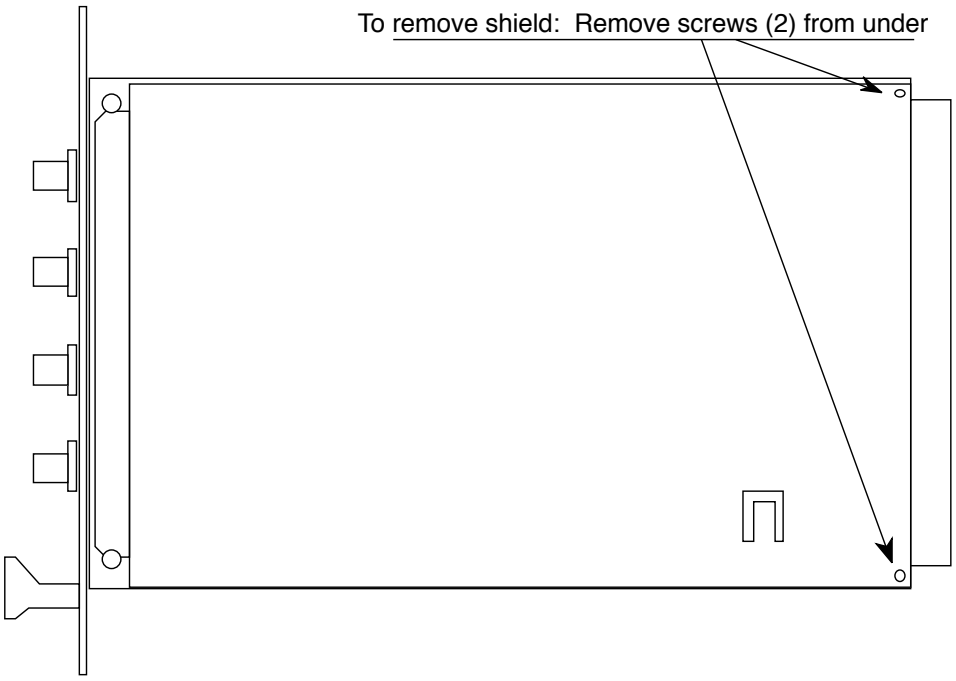
On-board potentiometers

Access to on-board potentiometers is normally not required. Exceptional circumstances could make it necessary.

Please note: Ex-factory calibration will be lost when on-board potentiometer settings are modified.

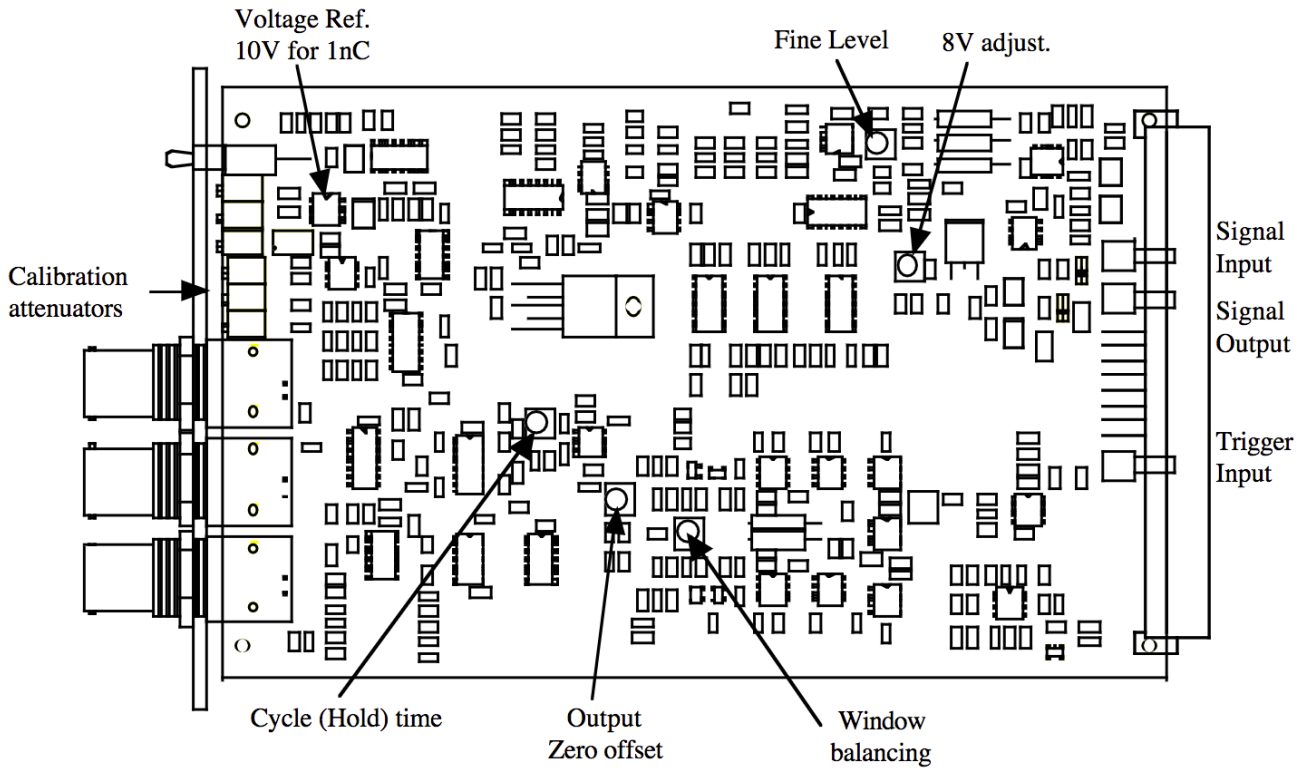
To access on-board potentiometers, pull the BCM-IHR-E out of the chassis. Any BCM-xx-E module can be removed and inserted "live", while the power is ON.

Remove the shield:



To adjust the on-board potentiometers, a card extender is necessary, such as Bergoz Instrumentation's BCM-XTD (See chapter "Card Extender BCM-XTD" page 28).

On-board potentiometers



Fine Level
Continuous gain adjustment: +-1 dB
Factory adjusted for 2.000 V BCM output corresponding to 1 nC at lowest gain: 0 dB in first stage and 6 dB in second stage.

Window Balancing
Potentiometer balances the respective gains of the Adding and Subtracting Integrators.
Factory set as shown on the "Factory Settings" label affixed to the BCM module.

Cycle (Hold) time
Determines the cycle duration "T_c".
T_c must be greater than the Hold time trigger delay + 2 x
T_w allows an adjustment from <20µs up to >600µs.
Factory set as shown on the "Factory Settings" label affixed to the BCM module.

Output Zero Offset
Trims the input charge amplifier's zero offset.
Factory set to zero offset for 1 kHz trigger frequency.

Note: Ex-factory calibration will be lost when on-board potentiometer settings are modified.

CONNECTOR PINS ALLOCATION

DB9 male Remote Control connector

Mating connector: use any DB9 female connector. Locking with UNC4-40 screws.

Gain selection	
Bit 0	4
Bit 1	8
Bit 2	3
Signal polarity	7
Calibration polarity	2
Calibration charge selection	
Bit 0	6
Bit 1	1
Calibration Enable	5
Ground	9

ACCESSORIES

BCM Chassis BCM-RFC/XX

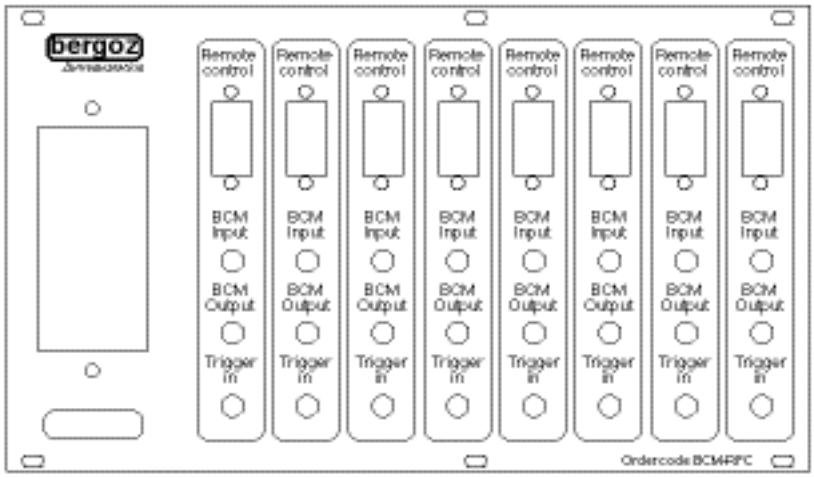
The BCM-RFC/XX chassis is built around a 19" Schroff rackable RF-shielded chassis.
Dimensions of the bin: 3U x 84F
Schroff reference: Europac Lab HF/RF #20845-283

The BCM-RFC/XX is available equipped for 1 up to 16 BPM stations. XX being the number of stations.

BCM-RFC/XX with less than 16 stations are partially equipped BCM-RFC/16. As a result, all BCM chassis are field-upgradable to the full 16-station chassis.

Chassis rear view

Shown here is a 1/2-width 19" rear panel. A chassis equipped with >8 BCM stations has two such half-width rear panels.



Chassis front

Unequipped stations are masked with RF-shielded blank panels.

Card Extender BCM-XTD

The card extender allows access to the BCM-IHR-E on-board potentiometers while it is connected to the chassis, thus to the readout and control system.

INSTALLATION OVER A VACUUM CHAMBER

Refer to "ICT Integrating Current Transformer User's Manual"

ACKNOWLEDGEMENT

The BCM system was developed at CERN during the 80's by Dipl. Ing. Klaus B. Unser to monitor the LEP beam.

Saint Genis Pouilly

Last revised March 2018

Annex I: DELTA Elektronika U-Series power supply units
AC Mains Voltage change Instructions

BCM-RFC chassis is equipped with one or more U-Series plug-in power supply modules from Delta Elektronika.

Each module consists of:
- a 3U-high 8F-wide front panel
- a 3Ux160mm base board reference P500A with a DIN H15 rear connector to plug in the chassis
- one or two +-15Vdc power supply blocks 5U-15-15.

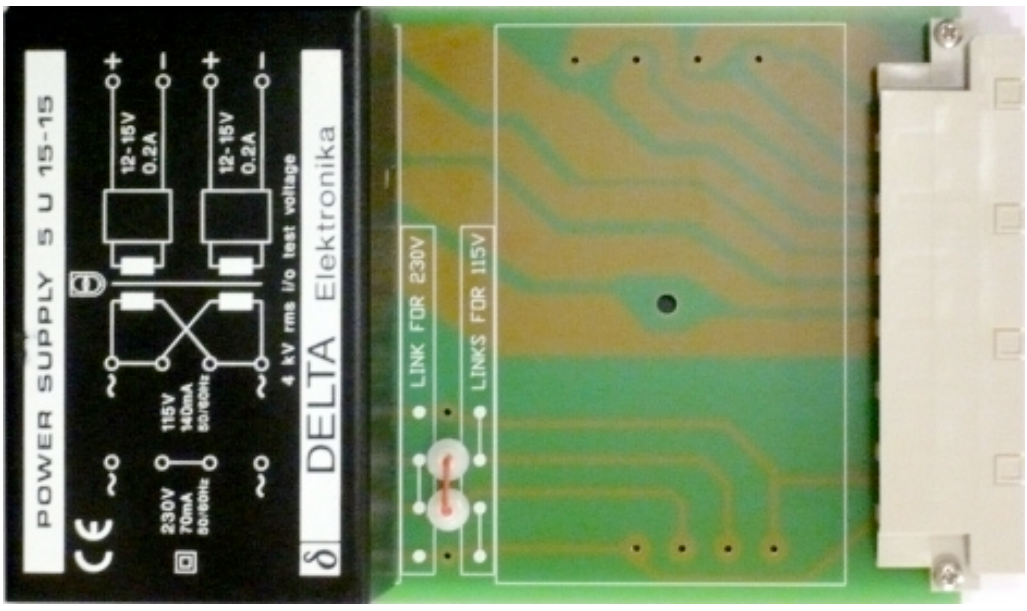
The power supply module must be adjusted to the local AC mains voltage.
If it is not set to the local AC mains voltage, the following adjustments need to be done:

The AC mains voltage adjustment is made by one of two "links" (jumpers) soldered onto the P500A base board.

In countries with 220Vac to 245Vac mains nominal voltage, e.g. Europe, U.K., one link must be soldered onto P500A in the location marked "LINK FOR 230V"
In countries with 100Vac to 125Vac mains nominal voltage, e.g. Japan, U.S.A./Canada, two links must be soldered onto P500A in the location marked "LINKS FOR 115V"

The +-15Vdc output voltages have been factory adjusted; they do not need to be readjusted according the AC mains voltage.

When the effective AC mains voltage is below the power supply voltage setting (e.g. applying 100 Vac to a power supply block set to 115V), power derating occurs.
This has been taken into account at the design stage, so no further readjustment is needed.



Step-by-step instructions:

- Pull out of chassis the Delta Elektronika plug-in power supply module (or modules).
- Remove the black plastic protection plate from the module solder side.
  It is held by 2 hex nuts and 2 Philips screws.
- Desolder the existing "link" (jumper) and remove it.
- Place one or two links in the desired locations:
  one jumper in LINK FOR 230V or two jumpers in LINKS FOR 115V.
- Reassemble the power supply module(s).

When changing the AC mains voltage, the chassis AC fuses may need to be changed:
The following chassis fuse calibre is required.
It depends on the AC mains voltage and the number of power blocks 5U-15-15 inserted in the BCM-RFC chassis.

For 220-245 Vac nominal mains voltage:
1 power supply 5U-15-15 block: 200mA fuse calibre
2 power supply 5U-15-15 blocks: 400mA fuse calibre
4 power supply 5U-15-15 blocks: 800mA fuse calibre
6 power supply 5U-15-15 blocks: 1.25A fuse calibre

For 100-125 Vac nominal mains voltage:
1 power supply 5U-15-15 block: 400mA fuse calibre
2 power supply 5U-15-15 blocks: 800mA fuse calibre
4 power supply 5U-15-15 blocks: 1.6A fuse calibre
6 power supply 5U-15-15 blocks: 2.5A fuse calibre

Note: Fuse calibre can safely be increased by 25% in case the recommended fuse calibre is unavailable.
E.g. Recommended 200mA fuse can safely be replaced by 250mA fuse.